Two-year Follow-up Study of Stress-related Disorders among Immigrants to Israel from the Chernobyl Area

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We report on findings from a 2-year follow-up study of immigrants originating from exposed areas around the site of the 1986 Chernobyl accident matched with comparison subjects emigrating from other republics in the Confederation of Independent States. In the initial study of 708 immigrants, the samples were matched by age, gender, and year of immigration. We assessed two exposure groups—high and low—by estimating levels of ground cesium contamination from the International Atomic Energy Agency maps. We reinterviewed 520 immigrants from the first wave of data collection (a reinterview rate of 73%), 87 from high-exposure areas, 217 from low-exposure areas, and 216 comparison subjects. This study examined the prevalence of symptoms of posttraumatic stress disorder (PTSD), depression, somatization, anxiety, and physical effects (high blood pressure, acute symptoms, and chronic illness). The results obtained in the first wave conducted 8 years after the accident showed that psychological symptoms were significantly higher in exposed respondents than in the comparison group. During the second wave (10 years after the accident) we observed a decline in the prevalence of PTSD and related distress except for somatization, which remained at the same level. An association between exposure and high blood pressure was observed in the first wave of data, but was not still significant in the second wave of data collection. The proportion of those who reported three or more chronic health problems was 48.3% among the high-exposure group, 49.3% in the low-exposure group, and 30.6% in the comparison group ($p = 0.0003$). The most commonly reported problems were heart disease, problems with vision or hearing, migraine headaches, problems with the lymphatic system, and arthritis. Based on the results, it was concluded that the Chernobyl accident was a powerful stressor, having a strong impact on both mental and physical health. Since all respondents were engaged in the process of acculturation and accommodation to a new country after emigration, it is encouraging that this study shows that levels of psychological distress are waning as the new immigrants are absorbed into Israeli society. However, there still remains some independent effect on health associated with the experience of the Chernobyl accident. — *Environ Health Perspect* 105(Suppl 6):1545–1550 (1997)

Key words: immigrants, cardiovascular disease, chronic illness, depression, somatization, PTSD, longitudinal study, Chernobyl, radiation

Introduction

Today, 10 years after the Chernobyl nuclear accident, it seems obvious that the worst technological accident of this century should have caused extensive psychological distress to residents of the area. Yet, many approach the study of the accident's aftermath mainly from the viewpoint of cancer-related outcomes, extrapolating from the results of the atomic bomb survivors. The recent publication, "Effects of A-Bomb Radiation on the Human Body," summarized the 45 years of research on this population (*1*). Yet no mention is made of any systematic study of the psychological impact of such a horrendous event, and current contacts with Japanese researchers have not uncovered any psychiatric epidemiology on the long-term effects (*2*). It was almost 20 years after the atomic bombs fell on Hiroshima and Nagasaki before the first psychohistorical study of survivors was published by Robert Jay Lifton in 1967. Learning from past omissions, and particularly from work done after the near-accident at Three Mile Island in the United States (*3,4*), it is fortunate that studies of the psychological impact of the Chernobyl nuclear accident have begun in the former Soviet Union and here in Israel (*5*).

The World Health Organization estimates that approximately 5 million people were exposed to at least mild levels of contamination (< 5 Ci ^{137}Cs /km^2), with an estimated 135,000 evacuated from their homes in the 30-km containment zone around the damaged Chernobyl reactor (*6*). Between 200,000 to 600,000 liquidators were brought in as salvage workers through "forced volunteering" to clean up the contamination.

Since 1989, when the gates of the former Soviet Union opened to allow Jewish immigrants to immigrate to Israel, some 120,000 to 150,000 persons from areas affected by the Chernobyl accident have arrived in Israel (*7*). Unfortunately, Israel has not yet established a special registry of those who came from the contaminated areas, so the exact numbers of those who emigrated are not available. This population constitutes the largest concentration of people exposed to the Chernobyl accident outside the former Soviet Union. This provides us with a unique opportunity to study the long-term effects of the Chernobyl accident on former residents of the contaminated zone.

This study assesses over a 2-year period the psychosocial functioning of the immigrants coming to Israel from exposed regions compared with a group of immigrants coming from presumably noncontaminated areas. Our paper addresses the following questions:

- Is there an effect on psychological functioning associated with exposure to the 1986 accident at Chernobyl as measured by a range of psychological indicators including posttraumatic stress disorder (PTSD)?

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Abbreviations used: CES-D, Centers for Disease Control - Depression; IAEA, International Atomic Energy Agency; IES, impact of events; PTSD, posttraumatic stress disorder.

- How does psychological functioning change over time?
- What is the extent in this population of reported acute symptoms after the accident and of current chronic illness?

What are the implications of these findings for intervention and further research?

Methods

Sample

In 1991 Kordysh et al. conducted whole-body counts for ^{137}Cs (radioactive cesium isotopes) on a sample of 723 adults over 18 years of age who responded to calls for immigrants to Israel wishing to be evaluated for their exposure. Body burden measurements were obtained together with interview and physical examination data.

Using this list of names in 1994, we tried to establish contact with a sample of 350 people from the exposed regions. During the period between 1991 and 1994, most immigrants had moved to permanent housing and thus we were able to recontact only 111. The final casual sample consisted of 374 persons (of the total 411 we contacted, a 91% response rate) 18 years of age and over from the exposed regions. This group was matched by age, sex, and year of immigration with a group of 334 immigrants from unexposed areas whose names were obtained from the Ministry of the Interior or through personal contacts. Thus, our total sample was composed of 708 individuals. Approximately 1 year after the initial contact, we recontacted our sample and were able to conduct follow-up interviews with 520 of the original respondents. Demographic characteristics of the two samples are shown in Table 1. Ninety-one percent of the immigrants arrived between the years 1989 and 1992. In the second wave of data collection, we ascertained what portion of the exposed sample were liquidators, and found that 30 (24 men and 6 women) or 5.8% had worked from a few days to a year or more at the Chernobyl site. Half this number had worked on site for a month or less. Their jobs included cleanup (n = 3), medical staff (n = 5), general services (n = 10), and other jobs such as professional staff (n = 12).

Questionnaire Development

We conducted open-ended interviews with immigrants from the areas around Chernobyl to elicit issues associated with the exposure and to develop the questionnaire. The instrument included questions on demographics, process of immigration, knowledge about and fear of cancer, subjective measures of stress, symptoms of PTSD measured by the Impact of Events Scale (IES) (*9*), coping, and stressful life events (*10*). The psychological outcomes included depression measured by the Centers for Disease Control-Depression (CES-D), anxiety, somatization, interpersonal difficulties, and obsessive–compulsive behavior using Derogatis SCL-90 subscales (*11,12*). Every effort was made to include measures validated in Russian or with immigrants. Blood pressure was tested at the beginning of the interview using a digital, battery-operated blood pressure cuff. Mean blood pressure measurements and the number or percentage of persons with elevated blood pressure (defined as > 140 mmHg systolic and > 90 mmHg diastolic) were used as indicators of hypertension in the study subsamples.

PTSD was measured by the 15-item IES, which is composed of two subscales: avoidance and intrusive thinking (*9*). It should be noted that this is a self-report measure and not a clinical diagnosis.

The reliability of the measures based on Cronbach's alpha coefficient ranged from 0.75 to 0.91, which is considered very good.

Exposure Status

Exposure status was estimated based on maps distributed by the International Atomic Energy Commission (IAEA) on levels of ground cesium. "More exposed" communities were defined as being those in which levels were more than 1 Ci/km^2 (> 37 GBq/km^2). "Less exposed" communities were those in which ground contamination was less than 1 Ci/km^2 (< 37 GBq/km^2); the "comparison" towns were those in which presumably there was no ground contamination (*13*).

From our qualitative interviews we postulated the sources of stress among immigrants from the area around Chernobyl. Among Israeli immigrants, stress associated with having been exposed to the Chernobyl accident may be attributable to a number of factors. These include factors such as: *a*) the perception that events surrounding the accident had the potential to be harmful to self and family, both in the present and in the future; *b*) a high level of uncertainty about the actual facts related to contamination and exposure and a lack of reliable scientific information about the effects of the accident; *c*) personal losses from the accident including such things as belongings, homes, a safe and familiar environment, financial security, job and personal status; *d*) the stress of immigration, which often involved changes in culture, language, status, political power, jobs and employment, supportive social networks, leisure-time activities, food, and natural settings; *e*) new stressful life events that have taken place since 1986; *f*) changes in health status for self and other family members, some of which may be related to Chernobyl exposure, and some of which may not; *g*) the nature of technological disasters during which one is thought to be in control but suddenly is not; and *h*) certain personality characteristics that reflect vulnerability or hardiness in the face of stressful life events.

This study was designed to determine how some of these sources of stress among Israeli immigrants interact to affect long-term psychological functioning and health status 8 and 9 years after the Chernobyl accident. Unfortunately, data were not available on the health status or personality characteristics of the immigrants before the accident or immigration. Specifically, sense we assessed current psychological symptoms together with self-reported health status among former residents of the areas around Chernobyl

Table 1. Summary of demographics, wave 1 and wave 2 samples.

		Liquidators[a]	More exposed	Less exposed	Comparison	Total
Demographic characteristic	Wave 1	Not assessed	n=121	n=253	n=334	n=708
	Wave 2	n=30	n=87	n=217	n=216	n=520
Response rate (wave 2)			71%	88%	65%	73%
Gender[b]	Wave 1					
Male			42% (57)	43% (103)	45% (133)	41% (293)
Female			58% (80)	57% (137)	60% (198)	59% (415)
	Wave 2					
Male		80% (24)	34% (25)	47% (94)	43% (91)	45% (234)
Female		20% (6)	66% (49)	53% (107)	57% (123)	55% (285)
Mean (SD) age in years	Wave 1		47.8 (15.9)	49 (17.3)	47.1 (16)	48 (17)
	Wave 2	48.5 (13.9)	50 (16.2)	50.5 (16.7)	48.3 (16.5)	49.4 (16.3)

[a]Data on liquidators were not assessed in wave 1. [b]Numbers in parentheses refer to number of individuals.

currently residing in Israel and compared these with the same factors for immigrants from noncontaminated Republics.

The specific research questions we sought to answer were *a*) Does exposure to the Chernobyl nuclear accident affect psychological variables such as PTSD, depression, somatization, and anxiety among Israeli immigrants and does psychological status change over time? *b*) To what extent are acute and chronic conditions reported by respondents, and what is their association with psychological distress?

Results

We used the multivariate analysis of variance to compare the level of psychological outcomes by exposure over time (from wave 1 to wave 2). The model was a mixed one with inter- and intraobserver effects and two independent variables (time of interview and exposure status [liquidators most exposed, those less exposed, and the comparison group]).

Psychological Measures over Time

Figures 1–4 show the changes in the four psychological measures over time for PTSD (IES), depression, anxiety, and somatization. Figure 1 shows that exposure had a significant effect on PTSD symptom scores at both interview times and that there was a significant overall decrease over time in PTSD scores. In addition, there is a significant interaction of time by exposure ($F_{(3,482)} = 7.85$, $p < 0.0001$). The source of this interaction is from the relatively greater decrease in PTSD scores for the comparison group relative to the decrease in the exposed groups.

In Figure 2, a significant effect of time is apparent for depression scores, while the exposure effect is apparent only at time 1 between the exposed and comparison groups ($p < 0.001$). The liquidators are the most depressed at time 1, but this disappears by time 2 because there is no significant exposure effect at this point. The results for anxiety are shown in Figure 3 and reveal a significant effect for exposure at both time points, particularly among members of the more exposed group, and a significant decrease over time ($p < 0.01$ and $p < 0.001$ for exposure and time, respectively).

Figure 4 shows the somatization scores by exposure over time. There is a significant exposure effect but no change over time ($p < 0.0001$). Somatization scores of the liquidators decrease in between time 1 and time 2, while for the other groups the picture remains static.

Physical Symptoms and Chronic Conditions

In wave 2, the respondents were asked about physical symptoms after the Chernobyl nuclear accident. There is a significantly greater proportion of persons in the exposed group who reported acute symptoms after the accident, ranging from 30% among liquidators, 26% among the most exposed, 14% among the less exposed, and only 2% among the comparison group ($\chi^2 = 44.36$, df=6, $p < 0.0001$) (Table 2). Among those who reported symptoms, more than half the liquidators and the most exposed group reported two or more symptoms. This was rarely true of the less exposed group (7%). The most commonly reported symptoms were nose bleeds, vomiting, skin irritation, and other acute reactions (fatigue, impotence, etc.). Nose bleeds, anemia or bleeding, or abnormal blood test results were more commonly reported among the most exposed groups compared with the liquidators.

Table 3 shows the percentage of persons in each exposure group reporting chronic conditions, from a list of 30 such conditions. Only conditions for which a significant exposure effect was found are shown. The data were analyzed for each chronic condition separately and also for the number of chronic conditions reported

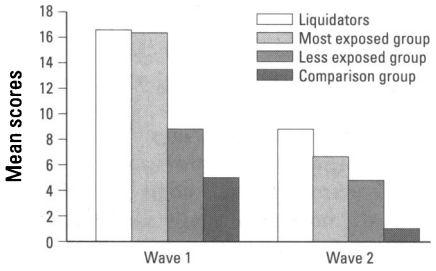

Figure 1. Comparisons of PTSD scores over time. Mean (SD) scores for PTSD on wave 1: 8.9 (10.4); wave 2: 3.7 (7.0). $p < 0.0001$. A significant interaction effect for exposure × time.

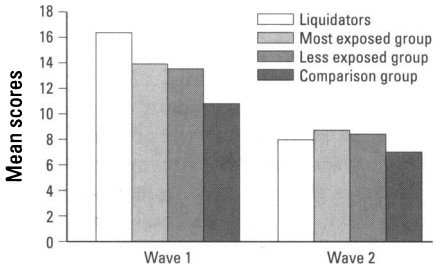

Figure 2. Comparison of depression scores by exposure over time. No exposure effect for depression scale at time 2. Mean (SD) for wave 1: 12.6; wave 2: 7.8 (7.1). $p < 0.0001$.

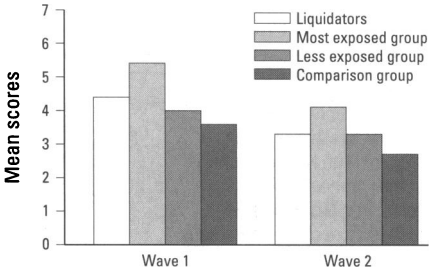

Figure 3. Comparison of anxiety scores over time by exposure. Means (SD) for wave 1: 4.0 (3.7); wave 2: 3.1 (3.1).

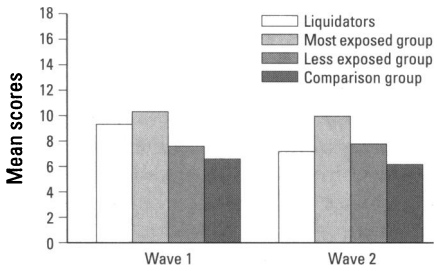

Figure 4. Comparison of somatization scores by exposure over time. Means (SD) for wave 1: 7.8(6.6); wave 2 (7.6) (6.6).

Table 2. Percentage (*n*) of self-reported acute symptoms following the Chernobyl accident by exposure.

Acute symptoms[a]	Liquidators, %	Most exposed, %	Less exposed, %	Comparison, %
Nose bleeds	10 (3)	12 (9)	4 (7)	0
Nausea or vomiting	10 (3)	11 (8)	8 (15)	0
Anemia or bleeding	3 (1)	7 (5)	5 (9)	0.5 (1)
Skin irritation or redness	13 (4)	10 (7)	6 (12)	0.5 (1)
Hair loss	10 (3)	5 (4)	2 (4)	1 (2)
Abnormal blood test results	3 (1)	10 (7)	4 (7)	0.5 (1)
Other acute reactions	27 (8)	16 (12)	11 (22)	0.5 (1)
More than one symptom	17 (5)	14 (10)	7 (15)	0

[a]Includes acute symptoms for which a significant exposure effect was found.

Table 3. Percentage (*n*) of reported chronic conditions by exposure.[a]

Condition	Liquidators, % *n*=30	Most exposed *n*=74	Less exposed, % *n*=201	Comparison, % *n*=214
Heart disease	33 (10)	30 (22)	28 (57)	16 (35)
Vision and/or hearing	23 (7)	23 (17)	22 (45)	13 (28)
Migraine headaches	23 (7)	22 (16)	21 (42)	11 (23)
Problems with lymphatic system	7 (2)	26 (17)	14 (28)	8 (18)
Arthritis or rheumatism	7 (2)	18 (13)	16 (33)	7 (14)
Chronic nervous trouble	7 (2)	11 (8)	5 (11)	2 (5)
Three or more chronic conditions	57 (17)	47 (35)	49 (98)	30 (65)

[a]Includes only those conditions in which a significant exposure effect was found.

by the respondents. The most commonly reported conditions among the exposed group were heart disease (around 30%), problems with vision or hearing (23%), and migraine headaches (22%). Among the most exposed group, 23% reported problems with the lymphatic system, 18% reported arthritis or rheumatism, and 11% reported chronic nervous problems. For those chronic conditions reported by more than 15% of the total sample, the liquidators resemble the most exposed group. When the condition is fairly rare, the liquidators resemble the control group, because the numbers are too small to give a correct representation. Counting all chronic conditions combined, 57% of the liquidators reported three or more chronic conditions, 47% of the most exposed and 49% of the less exposed, whereas only 30% of the comparison group reported such a high level of morbidity.

Table 4 shows risk ratios associated with the exposure using the most exposed and the comparison groups as the index. Most of the chronic conditions show significant relative risk (*RR*) except for chronic nervous trouble, problems with vision/hearing, and migraines, which are of borderline significance. The risk ratios range from 1.5 to 2.8 and indicate that exposure brings increased risk for chronic conditions.

We examined the relationship between psychological measures and the total number of chrome conditions reported using Pearson's coefficient. The number of chronic conditions was correlated with PTSD at $r = 0.33$, somatization $r = 0.30$, depression $r = 0.27$ and anxiety $r = 0.23$ (all significant at $p < 0.01$, two-tailed test). We also calculated a Spearman correlation for each chronic condition and the four psychological measures (Table 5). Only correlations greater than 0.20 are shown so as to present only those with both statistical and theoretical significance, as all correlations are significant because of the size of the sample. The results show that each chronic condition alone is weakly associated with PTSD. The chronic conditions most strongly associated with depression, anxiety, and somatization are heart problems, migraine, and problems with the lymphatic system. Stomach and liver problems and diabetes are correlated only moderately with somatization, and high blood pressure and vision and hearing problems are more significantly associated with somatization and anxiety. Mental problems and anxiety are moderately correlated.

Blood Pressure and Pulse Rate

We reported in previous work that we detected an exposure effect in a self-referred sample examined in 1991. In this sample, 20% from high exposure areas and 16% from less exposed areas showed elevated systolic blood pressure (> 140 mmHg) (*8,14*). Elevated diastolic blood pressure differed similarly between the more and less exposed groups. Age- and sex-specific analyses showed that statistically different levels were apparent in older age groups (males over 48 and females over 58 years of age). Among women betweeen 28 and 47 years of age, there was a significant difference between the more and less exposed groups in diastolic blood pressure as well. In the 1994 sample, 33% of the more exposed, 34% of the less exposed, and 23% of the comparison group had elevated systolic blood pressure. This difference is statistically significant in chi-square analyses at $p < 0.01$. A similar trend was apparent in diastolic blood pressure (26, 22, and 16%), which approaches statistical significance ($p = 0.07$). Age- and sex-specific analyses show that the most pronounced differences occur in systolic blood pressure for males over 48 years of age, and for diastolic blood pressure in the age group 28 to 37 and 48 to 57. For women the most consistent differences appear in the over 48 age group in diastolic blood pressure. The relationship between exposure and high blood pressure was much more pronounced with

Table 4. Relative risk ratios of exposure for different chronic conditions comparing most exposed and comparison groups.

Condition	Relative risk ratio	95% CI	Significance[a]
Heart disease	1.88	1.09–3.22	0.028
Vision and/or hearing	1.77	0.95–3.29	0.09
Migraine headaches	2.0	1.02–3.90	0.056
Problems with lymphatic system	2.88	1.35–6.12	0.006
Arthritis or rheumatism	2.57	1.12–5.88	0.03
Chronic nervous trouble	1.57	0.63–3.89	NS
Three or more chronic conditions	1.57	1.09–2.26	0.02

Abbreviations: CI, confidence interval; NS, not significant. [a]Significance levels after Yate's correction.

Table 5. Correlations between psychological measures and chronic conditions.[a]

Chronic condition	Depression	PTSD	Somatization	Anxiety
Heart	0.23	<0.2	0.43	0.33
Migraine	0.2	<0.2	0.32	0.26
Lymphatic system	0.27	<0.2	0.42	0.33
Muscular skeletal conditions	0.24	<0.2	<0.2	0.26
Arthritis	0.21	<0.2	<0.2	0.21
High blood pressure	<0.2	<0.2	0.38	0.29
Visual and/or hearing problems	<0.2	<0.2	0.31	0.27
Neurological problems	<0.2	<0.2	0.26	0.3
Stomach trouble	<0.2	<0.2	0.28	<0.2
Liver problems	<0.2	<0.2	0.26	<0.2
Diabetes	<0.2	<0.2	0.2	<0.2
Mental problems	<0.2	<0.2	<0.2	0.21

[a]All correlations presented are significant at the $p<0.0001$ level.

Table 6. Mean blood pressure of immigrants who report either hypertension or heart disease.

Reported condition	Systolic blood pressure Mean	Systolic blood pressure SD	Diastolic blood pressure Mean	Diastolic blood pressure SD
Heart disease				
Wave 1 results				
Yes (n=104)[a]	146.9	25.9	87.1	12.8
No (n=317)	127.2	20.5	79.2	12.3
Wave 2 results				
Yes (n=124)[a]	142.9	24.2	85.1	12.9
No (n=393)	127.2	16.4	80.5	10.3
Hypertension				
Wave 1 results				
Yes (n=133)[a]	151.2	24.1	89.4	12.6
No (n=288)	123.3	17.2	77.3	11.7
Wave 2 results				
Yes (n=148)[a]	149.9	19.9	89.6	12.4
No (n=369)	123.4	13.6	78.3	8.7

[a]All paired t-tests between those with the disease and those without are significant at the $p<0.0001$.

the subgroup of those with high scores on PTSD (*14*).

In the wave 2 follow-up, the differences in blood pressure between the exposed and comparison groups were no longer significant. However, there were differences in pulse rate, with the mean rate of 72.7 (SD 8.7), 72.05 (SD 9.8), 71.48 (SD 8.05), and 68.8 (SD 8.62) for liquidators, more exposed, less exposed, and comparison groups, respectively. A one-way analysis of variance shows that the comparison group pulse rate is significantly lower than the exposure group's ($F_{(3,512)} = 3.6$ $p<0.05$).

Furthermore, we found that for those who reported either hypertension or heart disease in wave 2, mean blood pressure rates were significantly higher at both data collection times than blood pressure rates for those without these problems (Table 6). It is also apparent that among those with either type of morbidity, mean systolic blood pressures were lower at wave 2. These findings corroborate the self-reported measures.

Discussion

Symptoms reported by the respondents seem to indicate that exposure to radiation from the Chernobyl accident, whether to low levels of ionizing radiation or to stressful events that accompanied the accident, are significantly related to morbidity of several types—psychological, physiological, and physical. It is encouraging, however, that both psychological and physiological measures tend to improve over time. This indicates that with greater time and distance from Chernobyl-related events and from immigration there is less distress. New research among normal populations has shown that for a subgroup of those originally showing signs of PTSD, about 60% will recover and 40% will continue to have symptoms over a long period of time, regardless of whether they received treatment (*15*).

Of all the chronic illnesses about which we collected data, only a handful showed significant associations with exposure; cancer was not one of them. It is interesting that some of the problems that are significantly correlated with exposure in this sample—arthritis, lymphatic problems, heart disease, and chronic nervous trouble—are also reported among Russian and Latvian liquidators, whereas others such as increased respiratory diseases and gastrointestinal problems are not (*16,17*). The report that 30% of those exposed suffered from heart disease is a very significant finding and suggests a significant burden of cardiovascular morbidity.

Not only has increased cardiovascular disease been noted among liquidators, it was also detected among atomic bomb survivors (*1*). However, the mechanism by which cardiovascular disease was increased by irradiation was not discussed in follow-up studies of the population. The results indicated a slight radiation effect among heavily exposed survivors in both the incidence and mortality rates of ischemic heart disease and cerebrovascular disease. Because the data were of questionable validity, the causal issue remained unresolved. A possible biological mechanism may be through free radicals produced at the cellular level that interfere with lipid processing and acceleration of the artheosclerotic process (*18*). An alternative pathway may be through the impact of stress on the body (*19,20*).

Our findings also show that the self-reporting of hypertension and heart disease was corroborated by the clinical findings of blood pressure measurements. This validates the self-reports on these chronic illnesses. To more accurately validate the reports of chronic illnesses, it would be useful to reexamine this cohort.

All psychological measures appeared to improve over time except somatization. Somatization is characterized by multiple complaints over a long period that are inadequately explained by either physical disorder or physical injury. It should be emphasized that the scale used in this study is not equivalent to a clinical diagnosis using the DSM-IIIR, for which 13 of 35 symptoms must be expressed (*21*). Furthermore, questions that form the somatization scale overlap with physical symptoms such as weakness in parts of the body, sore muscles, or heavy feelings in arms or legs.

Many people confuse somatization with hypochondriasis. The difference between somatization disorder and hypochondriasis is that the former relates to specific physical complaints and the latter does not focus on any particular set of symptoms but mostly reflects the fear that he or she might have a serious disease.

The implications of the continued level of somatization reflects the high burden of chronic disease reported by the exposed groups. As our results show, the presence of chronic illness is not associated with PTSD but rather with somatization, anxiety, and depression.

Limitations and Implications for Further Research

We based our study on retrospective recall of symptoms, which are subject to recall bias. There was no clinical validation by independent psychoevaluation of psychological outcomes such as PTSD and depression. Furthermore, some psycho-logical measures such as depression, somatization, and anxiety are likely to be strongly associated with physical symptoms, particularly in the case of chronic conditions. Because the study was begun 8 years after the Chernobyl accident, we lack data on changes in psychological functioning closer to the time of the accident as well as having no measures of personality, functioning, and health status before the accident.

Although our sample is similar to the demographic make-up of the immigrant population, we are uncertain how representative the sample is because we lack a registry in Israel of those who immigrated from exposed areas or who were liquidators. We

firmly support ongoing efforts to establish such a registry. Because of the high levels of chronic illness among this particular cohort, it is important to continue to follow them and to include more specific evaluations of illnesses such as cardiovascular disease.

Conclusions

The accident at Chernobyl was the source of significant distress among exposed populations that has been found to decrease over time despite the strain of immigration. Reported chronic illness remains much higher in exposed populations than among other immigrants from the CIS, and contributes to continued psychological distress. An appropriate intervention model would combine a medical approach with psychological and stress managment programs.

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